Delft
Sensor Systems

HNV-3D

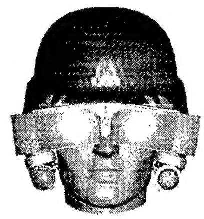
Multipurpose head mounted display

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

Delft Sensor Systems

HNV-3D

Holographic Night Vision Goggles



Description

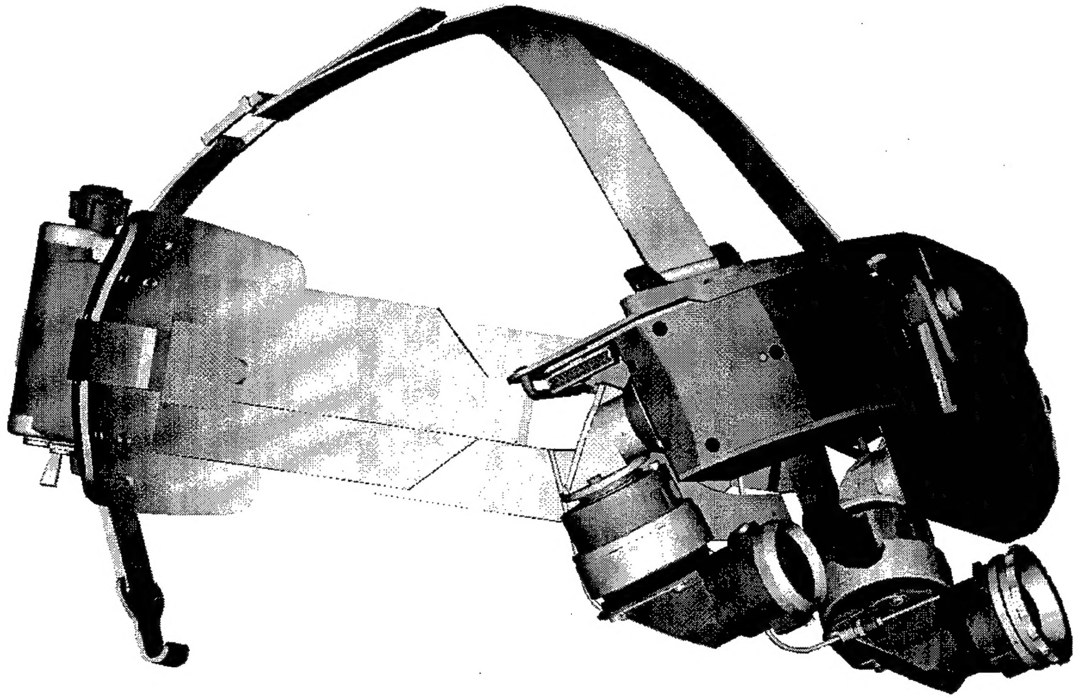
HNV-3D stand for Holographic Night Vision goggles with 3 Dimensional vision perception and sensor fusion. They have been especially developed for the advanced future needs of individual soldiers, drivers, special forces, helicopter crew, ...

The lightweight HNV-3D goggles are considered to cover the requirements of the soldier of the 21st century. They offer a unique concept of image mixture with total depth perception and day/night awareness of the battlefield environmental situation. Due to the Holographic Optical Elements (HOEs) total see-through image is guaranteed in a large field of view during unexpected changes in light level conditions. Data information (such as digitised battlefield information) is constantly available in the field of view and can be consulted by the user at any time without disturbing the observation of the outside world.

TECHNICAL SPECIFICATIONS

Optical		
Magnification		1 x
Field of View (FOV)		
Night image :	Horizontal (HFOV)	40°
	Vertical (VFOV)	30°
See-through image :	Horizontal (HFOV)	110°
	Vertical (VFOV)	70°
Data :	Diagonal	25°
Objective Focus		25 cm to inf
Interpupillary distance	Adjustable	57 till 69 mm
Eye Relief		> 25 mm
Diopter adjustment	NA (user can wear glasses)	
Exit pupil		> 7 mm
Distortion		< 7%
Tube		SuperGen or Third Gen
Resolution		
Data module		640x480 pixles monochrome
Night image		0.95 mrad at 100 mlux

Electronics	
Power source	Night module powered by 2AA 1.5 V batteries
Data input control	Belt Pack
Data format	VGA or PAL-NTSC
Physical	
Weight	max. 1.3 kg



				Gen.Tol.		Raw Material	Surfaces Roughn.grade	
				DIN7168-M			Surfaces treatment	
					Date	Name	Designation	Scale
				Sign.		JDV	GENERAL ASSY HNV-3D	1/5
				Check.				
				Norm.				
MASS: 0.0 gr				Delft Sensor Systems OIP NV			789.395	Sheet
	Rev.	Change	Date	Name			Replace: -	1/1
							CAD-model: HNV-3D	

Delft Sensor Systems

LIST OF ABBREVIATIONS

COG	Centre Of Gravity
FOV	Field Of View
HMD	Head Mounted Display
HOE	Holographic Optical Element
IR	Infra Red
I^2-tubes	Image Intensification tubes
LED	Light Emitting Diode

Delft
Sensor Systems

TABLE OF CONTENTS

1. INTRODUCTION ... 1

1.1 OBJECTIVE ... 1
1.2 BACKGROUND ... 1

2. TECHNICAL FEATURES ... 3

2.1 OPERATIONAL ANALYSIS ... 3
2.2 INTRODUCTION ... 4
2.3 EXISTING CONSIDERATIONS AND BACKGROUND ... 6
2.4 DESIGN CONSIDERATIONS AND TECHNICAL APPROACH OF HNV-3D ... 6
2.5 TECHNICAL SPECIFICATIONS ... 8
2.5.1 Magnification ... 8
2.5.2 Field of View ... 8
2.5.3 Objective Focus ... 8
2.5.4 Interpupillary Distance ... 8
2.5.5 Diopter setting and eye relief ... 8
2.5.6 Exit Pupil ... 8
2.5.7 Distortion ... 8
2.5.8 Resolution ... 9
2.5.9 Image Intensifier Tube ... 9
2.5.10 Automatic Brightness Cut-off and Bright Light Protection ... 9
2.5.11 IR Source ... 9
2.5.12 Power Source and control device ... 9
2.5.13 Data Input control ... 9
2.5.14 Weight and Balance ... 9
2.5.15 Environmental specifications ... 10

1. INTRODUCTION

1.1 OBJECTIVE

The objective of the HNV-3D is to provide the soldier with night vision goggles which have enhanced depth perception and to incorporate a head mounted display in the goggle suite for real or near real time data.

1.2 BACKGROUND

1. The HNV-3D goggles consist of :
   - See through face shield.
   - Two I^2 tubes to provide definitive depth perception.
   - Head mounted display

2. The two-tube (BI-TUBE) configuration provides the user with improved elevation and distance discrimination.

3. The use of holographics results in a DAY/NIGHT capability without the cost or weight of a traditional electro-optical solution.

4. The see-through characteristic eliminates the opaque architecture of traditional goggles which interferes with visibility during tube shut-down.

5. Human Engineering was of prime consideration in the design resulting in :
   - Optimized weight and center of gravity.
   - Interface and suspension providing ease of fixation on the head and helmet and maximum comfort.
   - Elimination of the opaque architecture of traditional goggle returning the wearer to normal movement functions.

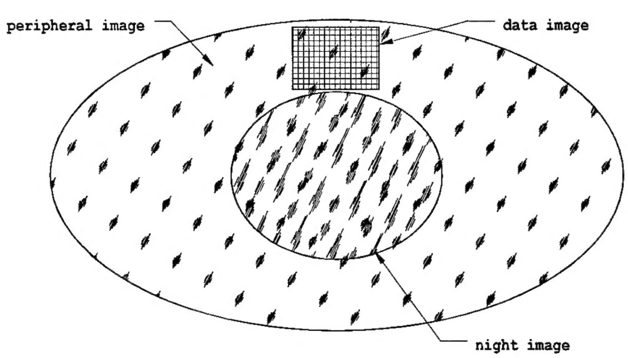
6. Data transmission requirement is fulfilled by means of adapting the characteristics of the Delft Sensor Systems HOPROS, a head mounted optical projection system already in production.

7. The objective is to enhance the war-fighting capability of the soldier through :
   - Elimination of opaque architecture of traditional goggles which limits individual vision during tube shut-down.
   - Simple day/night capability.
   - Enhanced depth perception.
   - Encourage user to wear goggles by adaption to the normal functions of the individual.
   - Data system for a real time or near real time response.

8. The holographic design allows for technical features not readily available in traditional design :
   - Superposition of the night vision image on top of the real scene
   - No requirement for diopter adjustment, allowing the user to wear prescription glasses while using the HNV-3D.
   - Providing enhanced depth perception through holographic and two tube image intensifiers clearly using all the normal senses to define perception.

9. Day/Night characteristics of the HNV-3D provide increased security of the individual in that the wearer is never blind, especially in urban warfare.

10. Tests revealed that data is easily acquired by the wearer. Improvements include (reference following illustration) :
   - Projection of data in an optimized position in the FOV.
   - Providing a facility to superimpose data for combined sensor resolution.



2. TECHNICAL FEATURES

2.1 OPERATIONAL ANALYSIS

From the very beginning of the introduction of image intensification tubes, optical designers followed a classical pattern of repackaging daytime designs to incorporate this unique invention. The first device to get broad attention was the Aerojet/Delft rifle scope, which really was an extension of daytime technology incorporating night vision capability. Announcement of this unique low light capability caught the imagination of technical and scientific writers triggering, if not a revolution in electro-optical science, at least a whole new industry dedicated to exploiting the image intensification technology. Alas, the concentration was on packaging and not on analysis. The packaging, however, had its merit and the user benefited from low light level periscopes, weapon sights and observation devices which helped roll back the curtain of darkness.

The improvement of the image intensification tubes, 2nd generation (inverter and microchannel plate), provided the impetus to design new and light weight night vision devices. It was now possible to design a personal night vision device for the individual user. Again, the optical design, followed classical patterns. It was now possible to design a light weight binocular, add a head harness, and name it a personal goggle.
Variations of this theme followed with the design of efficient beam splitters, and we had a one-tube CYCLOPS device resulting in reduced cost and weight.

The users benefited greatly from the revised packaging and the night fighting capability took a great leap forward.

The development of the 3rd generation image intensification tube provided a great increase in night capability. Troops equipped with 3rd gen devices had a force multiplier of great consequence. In fact, it was said, "we now own the night".

During the whole period of I^2 development, disturbing incident reports where trickling in from the field. Unexplainable one vehicle accidents ; helicopters, trucks and tanks trying to occupy the same geographic space of a vehicle already occupying that space, resulting in deaths, injuries and loss of equipment ; and spreading concern over the effectiveness of the night devices.

During the '94 AWE at Fort Benning, a training officer from NTC reported that less than 17 percent of the troops issued night vision goggles used them during training rotation. The general explanation was there was a lack of training in the night vision spectrum. This was not necessarily the proper conclusion. Of greater importance, was the after action report on Somalia, in which the helicopter pilots reported it was impossible to engage in operator controlled attacks because the night vision goggles

would shut-down going from light to dark to light areas putting the pilot in risk. This condition forced the commanders to limit their attack options to primarily a night level mode. The report closed with the comment that holographic goggles eliminated the dark-light-dark problem and that this technology should be vigorously pursued. This report confirmed the objective of Delft Sensor Systems-designers, that a see-through capability, provides a day/night capability without costly and heavy optics and that it encourages confidence in the user because OPAQUE ARCHITECTURE of the standard goggles is removed from in front of the users eyes.

Tests at the Dismounted Battlespace Battle Lab in the US with a single tube holographic goggle confirm, without exception, that the user is able to optimize his night vision capability. It was obvious that it is now possible to achieve, the lacking night vision characteristic, depth perception, through the employment of two I^2 tubes in a holographic design. Studies where made which fully supported this conclusion.

With the development of a two tube holographic goggle it is possible to declare that we truly own the night and that this provides the user with a force multiplier unachieved in prior years.

The holographic design returns the wearer to his/hers normally developed movements and sensors. The design eliminates OPAQUE architecture of traditional goggles (interfering with full range vision) and 2D display. It eliminates the psychological hesitation associated with transitional blindness caused by shut-down of I^2 tubes and uncertainty of distance or elevation. The characteristics of Delft Sensor Systems Holographics goes a long way in fulfilling the objective of "own the night" and the environment expected during the 21st century.

2.2 INTRODUCTION

The HNV-3D is designed to improve the situation awareness of the Individual Dismounted, enhancing the soldier's capability across the sensory spectrum and providing him with real or near real time data.

In order to fulfill this objective the HNV-3D consists of a Holographic stereoscopic image intensification system with enhanced depth perception and an integrated Heads-Up Display for enhanced data management.

Before going on with the conceptual design of the system a research was made on existing knowledge about the human factors related with sensor fused image presentation to a human being. It turned out in some design recommendations :

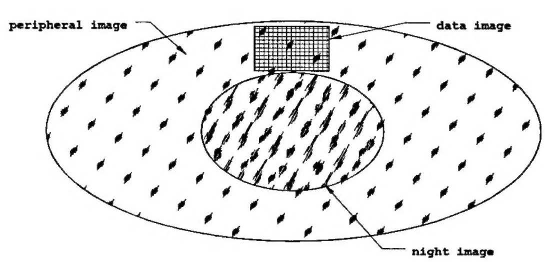
- Helmet/HMD comfort: Weight and center of gravity are crucial.
- Optical quality: Poor quality and optics incorrectly adjusted for each individual will lead to eye strain and false stereo effects.
- Field of view and resolution: A wide field of view is needed for peripheral information and to allow a lot of information. High resolution is essential...

- Display format design: Data and symbols must not obscure the outside scene with clutter or excess brightness.
- Image combination : There are several image sources -the natural scene, image intensifiers, head-up display-not all at once. There appears to be a human tendency to concentrate on one image to the exclusion of the others. Other problems are: relative brightness, overlaying HMD imagery on close scenes and possible misaccomodation (visual focusing) with virtual images.
- Accuracy: Tolerable miss-representation between HMD imagery and the outside scene.
- Sensor/helmet offset: A sensor is not always coincident with the humans eye position.
- The ideal solution is a narrow band source and an accurately matched narrow band reflector to ensure the best reflective properties, the least coloration of the scene and maximum outside world transmission. The technology which provides these ideals is holography.

The design of the HNV-3D copes with these recommendations as well as with the contributions to the enhanced warfighting capability which are mentioned as background of the design considerations described below.

Finally the HNV-3D offers lightweight stereo night vision with :

- large peripheral vision
- see-through capability
- superposition of data input images for command and control



The see-through feature is obtained using Holographic Optical Elements for optimum transmission and selective reflection.

The stereo night sight of high resolution is obtained by means of two image intensifier tubes.

The data presentation is projected to one eye on a virtual distance in the field of view of the user.

2.3 EXISTING CONSIDERATIONS AND BACKGROUND

Both bi-tube and single-tube conventional goggles have, as a consequence of their construction, several inconveniences.

First the center of gravity is located far in front of the users head, which results in an excessive turning moment acting on the head of the person.

Secondly the user has no peripheral field of view and will be blind by failure of the image intensifier tube or at high light level. At high light level, as on the battle field or in town guerrilla, the image at the screen of the image intensifier tube will indeed show a blurring. This results in resolution loss or even, at higher light levels, complete switching off of the tube. The optical components in front of the eyes will in such case cause a total obstruction of view and the only method in order to see again is to flip away or to pull off these goggles.

These inconveniences are overcome for a great deal by using an image intensifier tube with a narrow band phosphor (P43) at the screen in combination with holographic optical elements in each eye channel that allows a superposition of the night image reflected in this narrow band on the scene in the full band in see-through mode.

Due to the use of special developed unique holographic optical elements only reflecting in this narrow wavelengths band, the user keeps always a direct image of the real world, even by failure of the image intensifier tube as well at high light level as in the transition period between half dark and star light conditions. As an important result he always keeps the awareness about the surrounding situation due to the constant peripheral sight.

Another advantage is the position of the components with respect to the users head in such a way that ordinary ophthalmic glasses can be worn, which allows the goggles to work with fixed diopter setting.

2.4 DESIGN CONSIDERATIONS AND TECHNICAL APPROACH OF HNV-3D

Following design considerations were taken into account for the development of the improved and advanced new generation of night vision goggles for the soldier of the future:

- a peripheral visor with see through capability
- two independent I^2 tubes for stereoscopic view
- high quality relay optics and Holographic Optical Elements
- a display with its optical device for data transmission
- a power control unit
- a belt pack interface unit for data transmission control
- simultaneous focusing system of both objectives (master/slave)

- an IR flood light with a warning LED
- low battery power warning indication (flashing LED)
- an overall light weight and modular housing
- center of gravity close to the head COG by a new arrangement

The see-through solution due to the use of Holographic Optical Elements (HOEs) increases a lot the awareness and confidence of the soldier. A see-through sight gives him back the confidence of his own sensors what is crucial in stress situations and for the optimal functioning of the soldier.

The use of two image intensifier tubes make it possible to have a stereoscopic sight of the night image (depth perception).

The stereo configuration of the system was mainly chosen for two reasons: First the possibility of depth perception which is crucial for the landwarrior in an obstacle environmental area and for helicopter pilots. Secondly this configuration allows an arrangement of the optical components besides the head of the user so moving the center of gravity as close as possible to the center of gravity of the head. Further the security of use in case one tube fails in critical situations where the other tube still can continue to work.

The integrated additional data module, similar to the Delft Sensor Systems HOPROS system, projects data to one eye (left or right) so providing the soldier with information in the field of view related to command and control requirements on the battlefield without loss of eye contact with the environment. This projection module has an external power and signal supply so avoiding the extra weight of internal batteries. A belt pack is added for this signal and power control.

Special attention was paid for the ergonomic aspects, location of the center of gravity and the simplicity of the control devices.
System power will be supplied by 2 AA batteries or 2 x 3.3 V Lithium AA. This internal power source can be replaced by an external power source when the data module is activated through the belt pack "data and power control unit".

In order to be compatible with existing helmets the stereo configuration as designed attributes to arrange the several components in such a way that all the space above becomes free to match the equipment with the helmet.

The eye relief behind the backside of the visor allows the use of normal glasses or laser protection devices without the need of diopter adjustments. The weight of the front optics is compensated by the position backwards of the optical relay optic and tubes on both sides of the goggle.

2.5 TECHNICAL SPECIFICATIONS

2.5.1 Magnification

The magnification is unity over the full FOV.

2.5.2 Field of View

Night Image

The FOV is 40° horizontal and 30° vertical.

See-through Image

The FOV is 110° horizontal and 70° vertical.

Data

The FOV is 25° diagonal.

2.5.3 Objective Focus

The focus of the two objectives is linked by a master-slave control system allowing simultaneous focusing for both objectives from 25 cm to infinity.

2.5.4 Interpupillary Distance

The IPD is adjustable between 57 till 69 mm.

2.5.5 Diopter setting and eye relief

The eye relief is larger than 25 mm. No diopter adjustment are required, as the user can keep using his glasses if applicable.

2.5.6 Exit Pupil

The exit pupil of the eyepiece is larger than 7 mm.

2.5.7 Distortion

Distortion is less than 7% across the entire FOV when the objective is set at infinity.

2.5.8 Resolution

Data Module
The resolution is 20 lp/mm.

Night Image
0.95 mrad at 100 mlux (with OMNI IV-tube).

2.5.9 Image Intensifier Tube

The system allows for 2nd or 3rd generation 18 mm tubes. The mechanical dimensions accept an ANVIS tube equivalent to the MX-10160.

2.5.10 Automatic Brightness Cut-off and Bright Light Protection

The system has built-in electronic protection to minimize damage to the energized image intensifier tubes when subjected to a diffused bright source.

2.5.11 IR Source

An IR source is provided for use in zero and very low light conditions, which can be switched on permanently. A warning indicator LED is provided in the FOV whenever the IR LED is active.

2.5.12 Power Source and control device

The night module is powered by 2 AA 1.5 V batteries. The data module is connected to the belt pack. When connected the belt pack can also function as external power supply for the night module.

Buttons allow to control the HNV 3D even with gloves on.

A low battery power warning signal is available in the FOV (flashing LED).

2.5.13 Data Input control

A belt pack with basic control devices of power, data signal selection and interface is connected to the system with a flexible cable and connectors. Data from from the soldier's computer or other data sources will be accepted (VGA analogue interface).

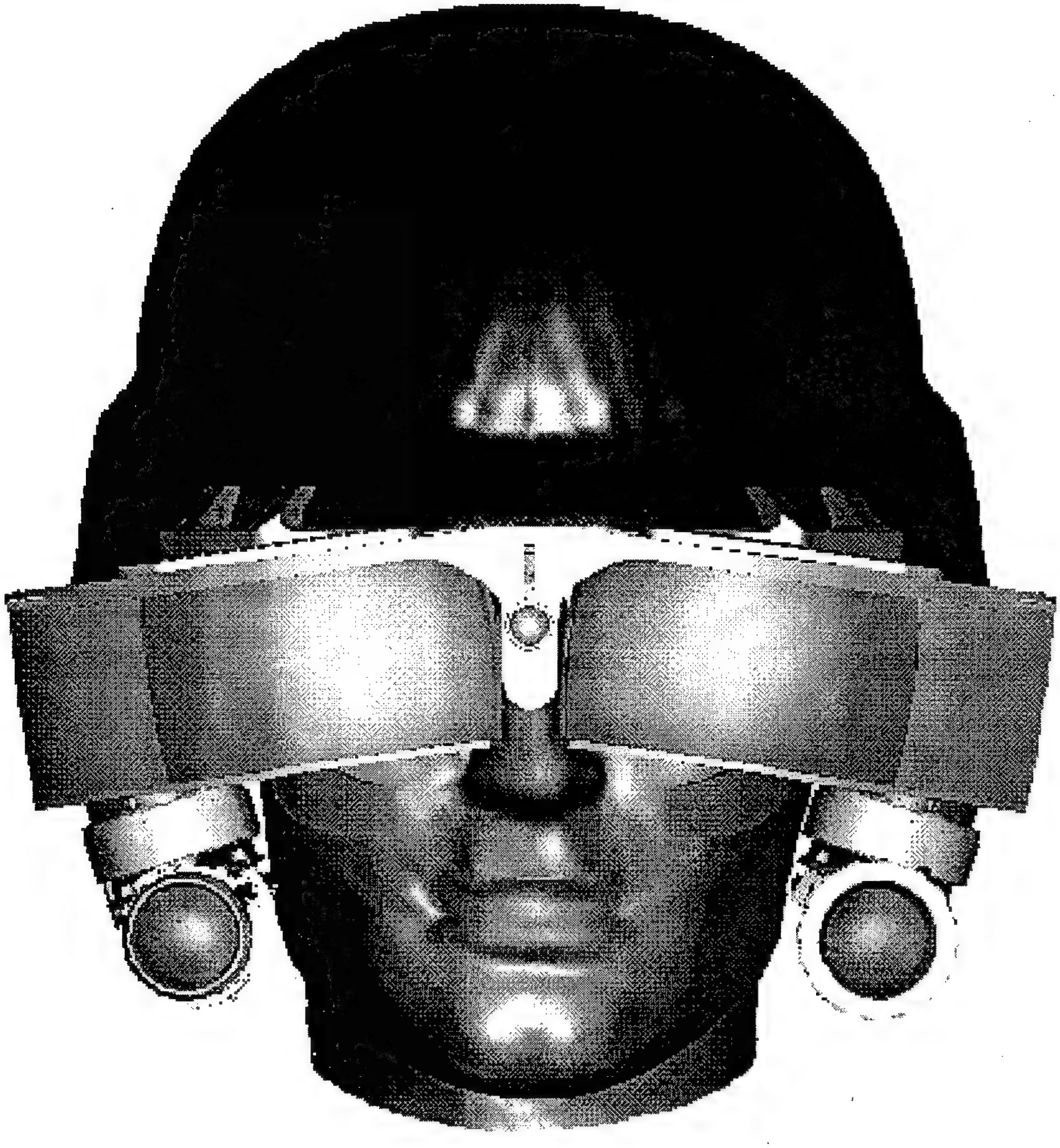
2.5.14 Weight and Balance

Weight and balance of the system are such that the system can be used comfortably. Head supported weight is maximum 1.3 kg.

2.5.15 Environmental specifications

The demonstrator systems are **not fully ruggedized** and consequently the full performance cannot be guaranteed over the complete range of operational conditions, specified in the MIL standards. The systems will however be constructed to the best internal standards of workmanship.

Delft Sensor Systems



Delft
Instruments

MINUTES OF MEETING

PROC. INSTRUMENT IDEN. (CONTRACT)
DAAB07-97-C-S618

Ref.:
RE-HNV3D/001

PRIME CONTRACTOR	CAGE CODE
Delft Sensor Systems-OIP/NV **Westerring 21** **B-9700 Oudenaarde, Belgium**	**B0012**

UBJECT
Kick-off meeting : Preliminary Design Review (PDR)

PLACE	DATE
Fort Benning, Columbus GA	**27 February 1997**

PARTICIPANTS

DBBL
K. McDonald
F. Mazzocchi
R. Reid
C. Thornton

NVESD
W. P. Markey
R. A. Spande

OIP n.v.
A. Boumdouha
W. Camphyn
B. Moll

FFE International
J. Frost

TO

AMSEL-RD-NV-ST-ITB

DBBL
K. McDonald
C. Thornton

DCMC NE-Belgium
R. Kelly

OIP n.v.
A. Boumdouha
B. Moll

FFE International
J. Frost

	NAME	PARAGRAPH	DATE
AUTHOR	**W. Camphyn**	Camphyn	05/03/97
REVISOR	**A. Boumdouha**	[illegible]	05/03/97

AGENDA

1. INTRODUCTION & BRIEF COMPANY DESCRIPTION

2. LINE DRAWINGS OF THE HNV-3D

3. CURRENT TECHNICAL CHARACTERISTICS

4. RESOLUTION OF OPTICAL PROBLEMS

5. FLOW CHART OF PLANNED PRODUCTION SCHEDULE

6. PROPOSED TEST PROCEDURE

7. DISCUSSION

1. INTRODUCTION & BRIEF COMPANY DESCRIPTION In annex. **2. LINE DRAWINGS OF THE HNV-3D** In annex. **3. CURRENT TECHNICAL CHARACTERISTICS** In annex. **4. RESOLUTION OF OPTICAL PROBLEMS** In annex. **5. FLOW CHART OF PLANNED PRODUCTION SCHEDULE** In annex. **6. PROPOSED TEST PROCEDURE** In annex. **7. DISCUSSION** <u>7.1. RESPONSIBILITIES</u> Pointed out was that the Dismounted Battlespace Battle Lab is in charge of the contract. Main point of contact is Project Officer K.L. McDonald, main purpose of the project is to enhance the soldiers warfighting capabilitiy. There will be a quarterly meeting in Fort Benning to discuss the status and progress of the project. <u>7.2. TEST PROCEDURES</u>	
Details of the test procedures will be ready within 60 to 90 days and will be supplied to Mr. C. Thornton by Mr. J. Frost.	**Action : FFE**
Besides the tests carried out as part of the contract, their will be extensive testing of the HNV-3D by the DBBL. These tests will also include driving with the HNV-3D. <u>7.3. GOVERNMENT FURNISHED EQUIPMENT (GFE)</u> DBBL will deliver to OIP n.v. 20 OMNI-4 tubes instead of the 3rd gen I^2 tube specified in the contract. The government furnished soldiers computer will be replaced by the Grund computer.	
The specifications of tubes and computer will be given to Mr. J. Frost.	**Action : DBBL/FFE**

7.4. DURATION OF THE CONTRACT Approval was given by Mr. C. Thornton to reschedule the dates in the contract to start from the kick off meeting. Mr. J. Frost will contact the contracting officer to adjust the contract.	**Action : FFE/OIP**

Kick-off meeting 27 February 1997

- Introduction and brief company description
- Line drawings of the HNV-3D
- Current technical characteristics
- Resolution of optical problems
- Flow chart of planned production schedule
- Proposed test procedure

Introduction & company description

OIP N.V.

Delft Sensor Systems™

History of a technology leader

Delft Sensor Systems

OIP N.V.

Delft Sensor Systems™

Committed to innovation

1919

Foundation
Optical precision instruments
(microscopes, binoculars, cameras)

EARLY 60's:

Electro-optics
- Pioneer HUD's F-104 Starfighter
- First European Laser development
- Holographics
- Fibre Optics

1970's:

Worldwide pioneer in MBT Fire Control Systems
LEOPARD 1: Belgium, Canada, Australia

Committed to innovation

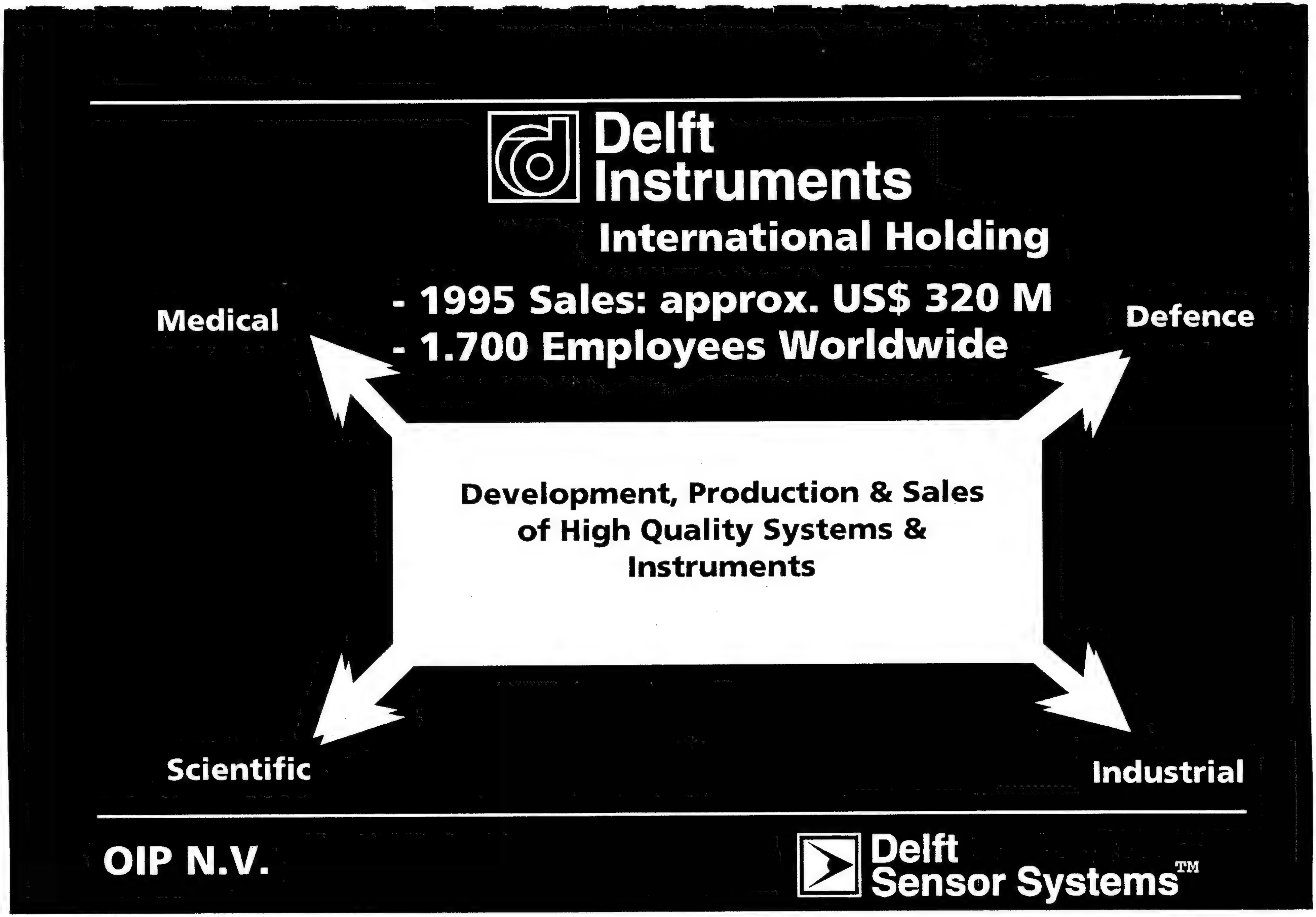
1980's
- Cost-effective FCS
- First participation to space programs
- Holographic Optical Elements

1988

OIP joined the Delft Instruments Holding

1990's
- Modernization Belgian Leo 1 MBT (Thermal Sights)
- Mass production of HNV's
- Helmet Mounted Displays
- Consolidation of all defence activities

TODAY
- Head-Mounted Optical Projection Systems
- International expansion (defense / civil / space)


Delft Instruments
International Holding
- 1995 Sales: approx. US$ 320 M
- 1.700 Employees Worldwide
Medical
Defence
Development, Production & Sales of High Quality Systems & Instruments
Scientific
Industrial
OIP N.V.
Delft Sensor Systems™

Delft Instruments

USA 18%
Row 24%
Europe 58%

Markets

Defence 12%
Industrial & Scient. 35%
Medical 53%

Fields

Industrial & Scientific

- ENRAF (petrochemical)
- NONIUS (X-Ray)
- Sales Subsidiaries

Defence

- Delft Sensor Systems (B, NL)
- DEP (II Tubes)
- Sales Subsidiaries (G, I)

Medical

- Enraf-Nonius (Fysiotherapy)
- Nucletron (Brachy- & Radiotherapy)
- Oldelft (Medical Imaging)
- Sales Subsidiaries

OIP N.V.

Delft Sensor Systems™

Activities

Manportable Passive (II) Night Vision Sights

Aiming Observatio n

Optical Sights & FCS for Tanks & Armoured Vehicles

Customized Projects

- Space
- Specific FCS
- Far IR
- Laser Rangefinder
- Helmet mounted displays

Capabilities

- R & D : Optics, Electronics, Assembly

- Workshops:
  - Optical: Fully equipped for conventional & Special optical components
  - Mechanical: Prototyping, tooling, customization, etc.

- Assembly: 1000 m^2 dark rooms with calibrated light sources,
  200 m^2 clean rooms (class 10.000/class 100)

Capabilities

- QC:
  - NATO AQAP-110 and ISO-9001 certified
  - Optical/mechanical/electronic on-line testing
  - MIL-STD environmental testing (temperature, humidity, vibrations, shocks)

- Logistics & Project management

Capabilities

- After Sales Service
- Technology Transfer
- Training
- Project Management

HUD's for tomorrows warriors:

HNV-3D

OIP N.V.

Delft Sensor Systems™

Background

- New trend towards 'Digital Battlefield'
- Need for additional functions to NVG's to increase soldiers awareness in the field
- Experience with HNV-1 proved the value of see-through holographic solutions
- Expertise gained on HVN-1, Viper & Hopros could be implemented in next generation

Objectives of HMD

- Elimination of opaque architecture of NVG which limits individual vision during tube shut-down
- Provide simple day/night capability
- Provide enhanced depth perception
- Encourage user to wear goggles by adaption to the normal functions of the individual
- Provide a data system for real time or near real time response

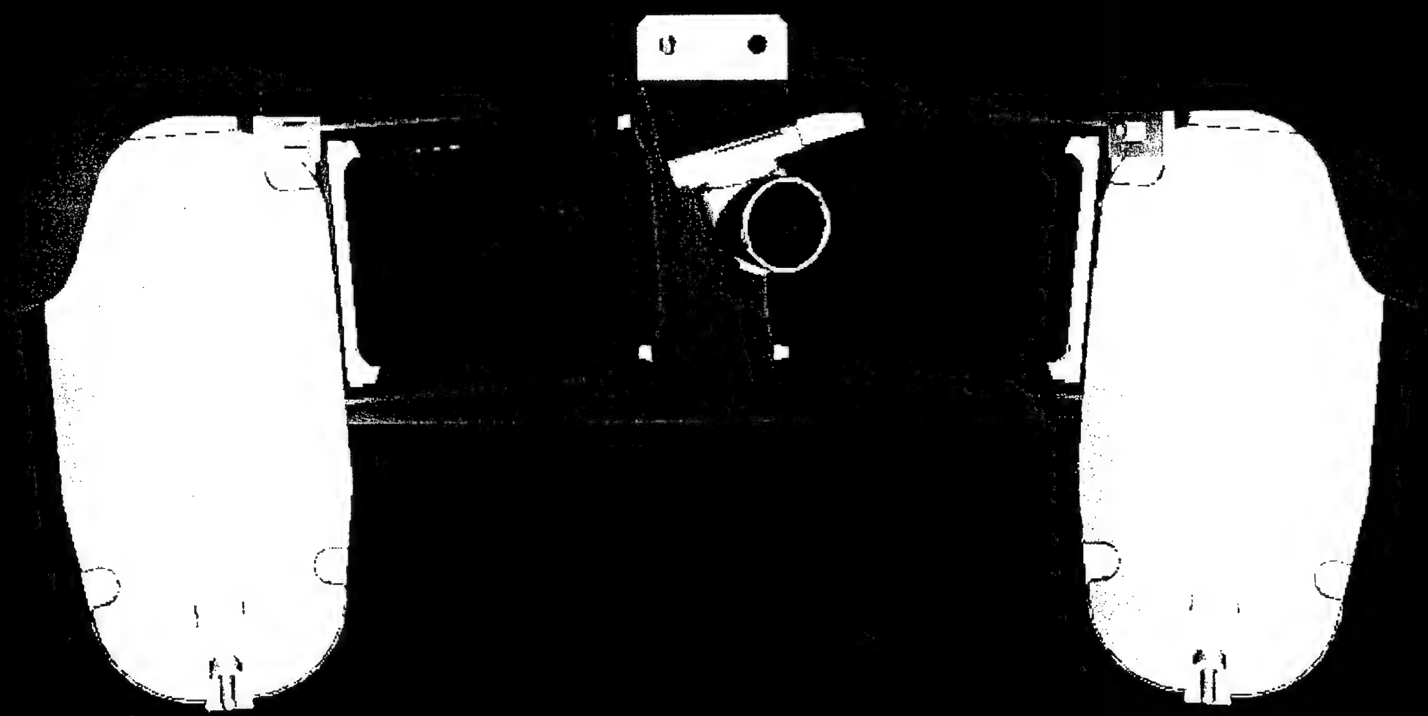
Basic design goals

- High resolution viewing
- Stereoscopy for depth perception & redundancy
- Low weight, compact & comfortable
- See-through with large peripheral sight
- Large field of view
- Helmet compatibility

Line drawings of the HNV-3D

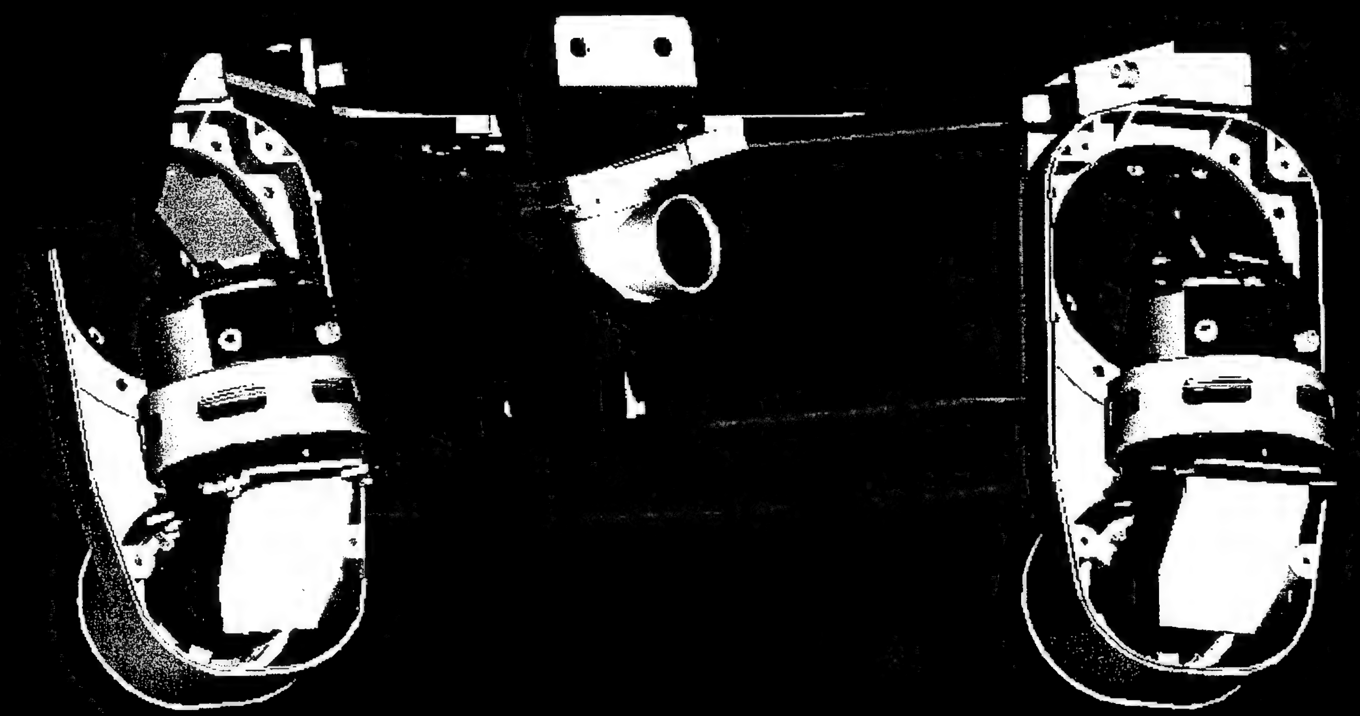
OIP N.V.

Delft Sensor Systems™



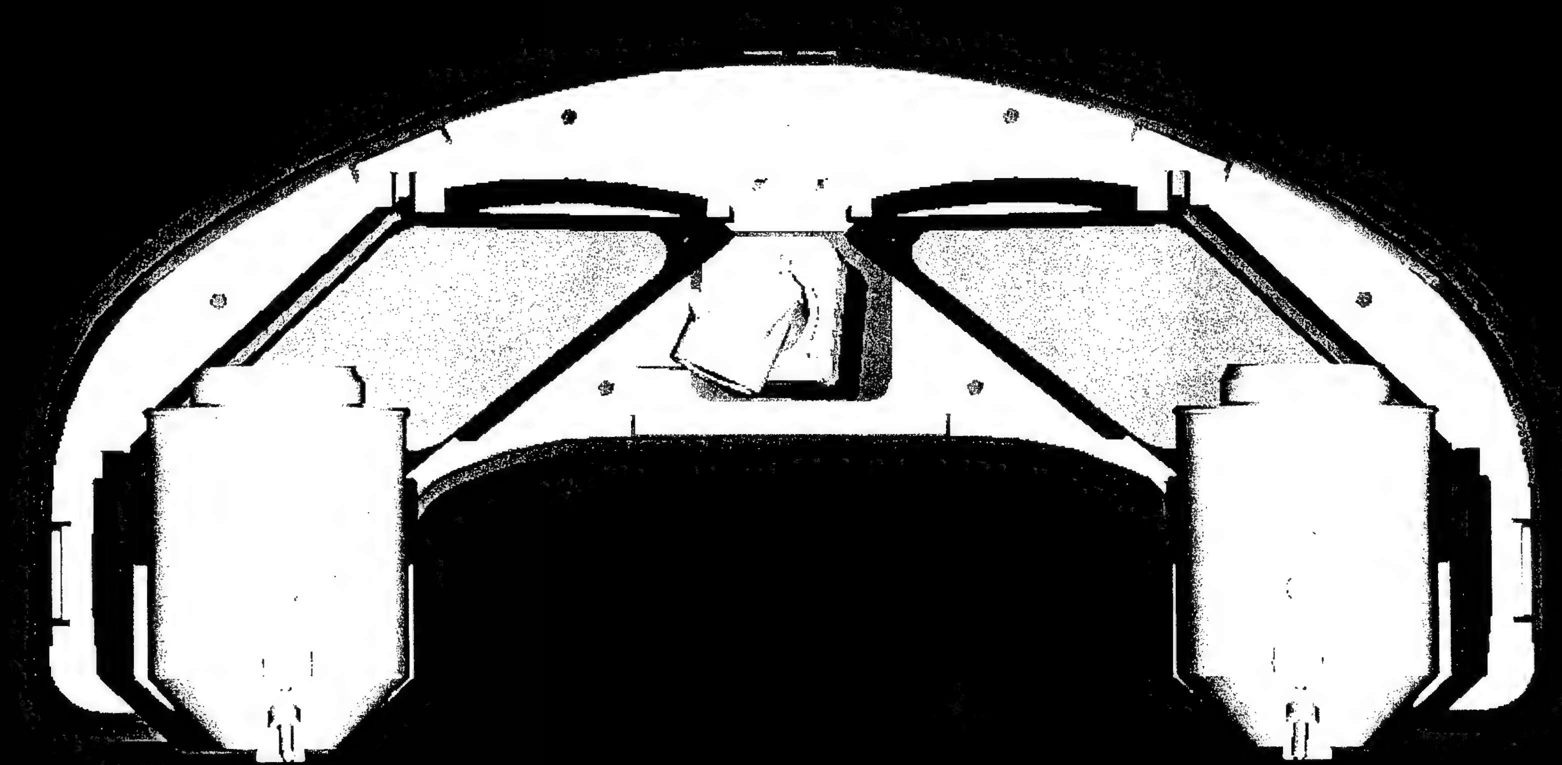
OIP N.V.

Delft Sensor Systems™



OIP N.V.

Delft Sensor Systems™



OIP N.V.

Delft Sensor Systems™

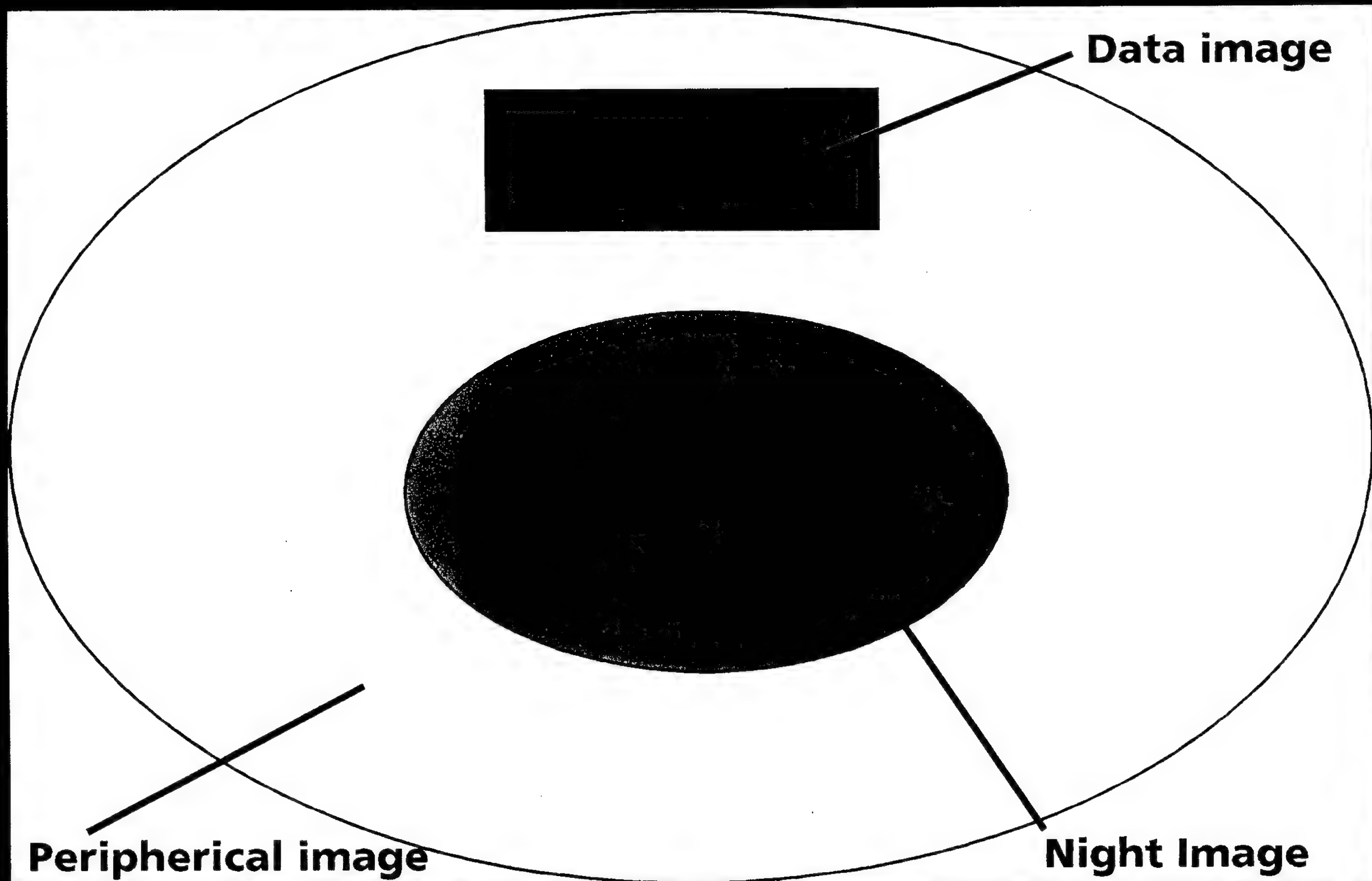
Current technical characteristics

OIP N.V.

Delft Sensor Systems™

Optical

- Peripheral visor with see-through capability
- Unit magnification
- Two I^2 tubes (3rd Gen.) for stereo view
- Relay optics & Holographic Optical elements
- Master/slave focus control
- No diopter settings required



OIP N.V.

Delft Sensor Systems™

Mechanical/Electrical

- Belt pack interface unit for data control
- Modular int/ext power supply
- Power control push-button on goggle
- Low power warning indication
- IR flood light with warning LED
- Overall lightweight & compact
- Center of gravity close to head COG
- Adjustable face mask fixation for head- or helmet mounting

Optical problems encoutered in design

OIP N.V.

Delft Sensor Systems™

- Superposition of night sight on top of day sight
- Incorporation of data
- Stray light

Tools for optical modeling

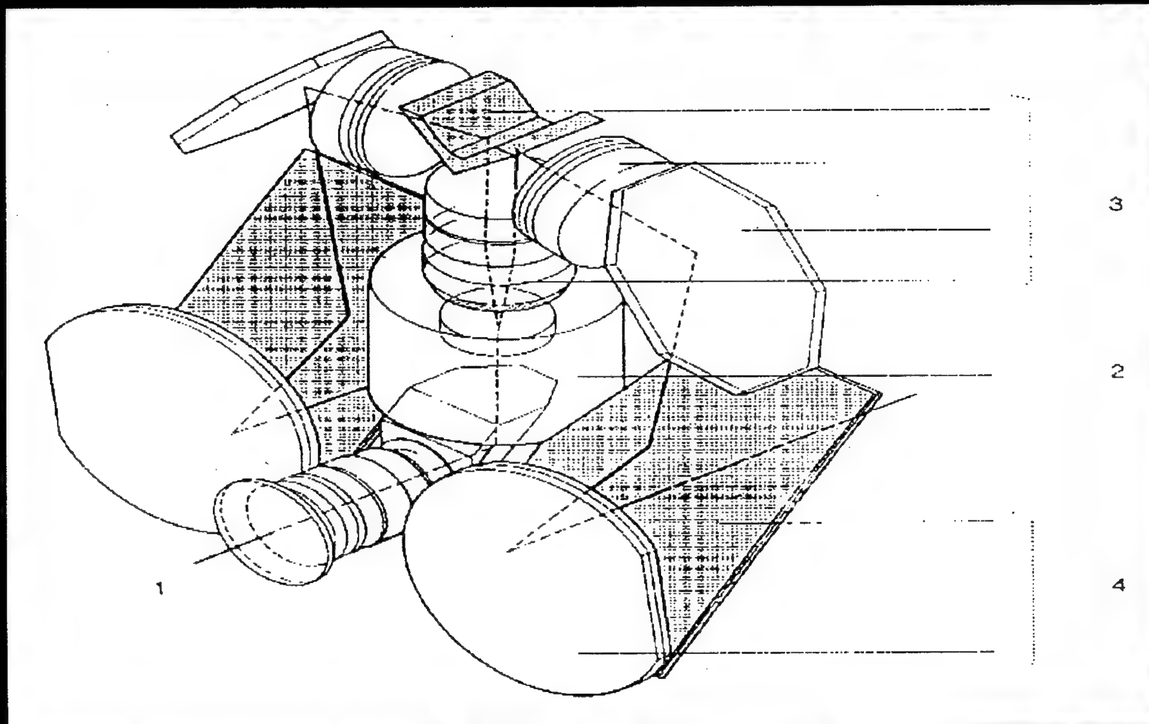
- Code V
- Zemax

- ASAP stray light analysis

HOE's

- Holographic optical elements
- HOE's can be made highly reflecting for the light emerging from the I^2T without significantly decreasing the light transmission form the outside world
- HOE's can perform optical functions which cannot be obtained with conventional optical components

Application of HOE's in the HNVG



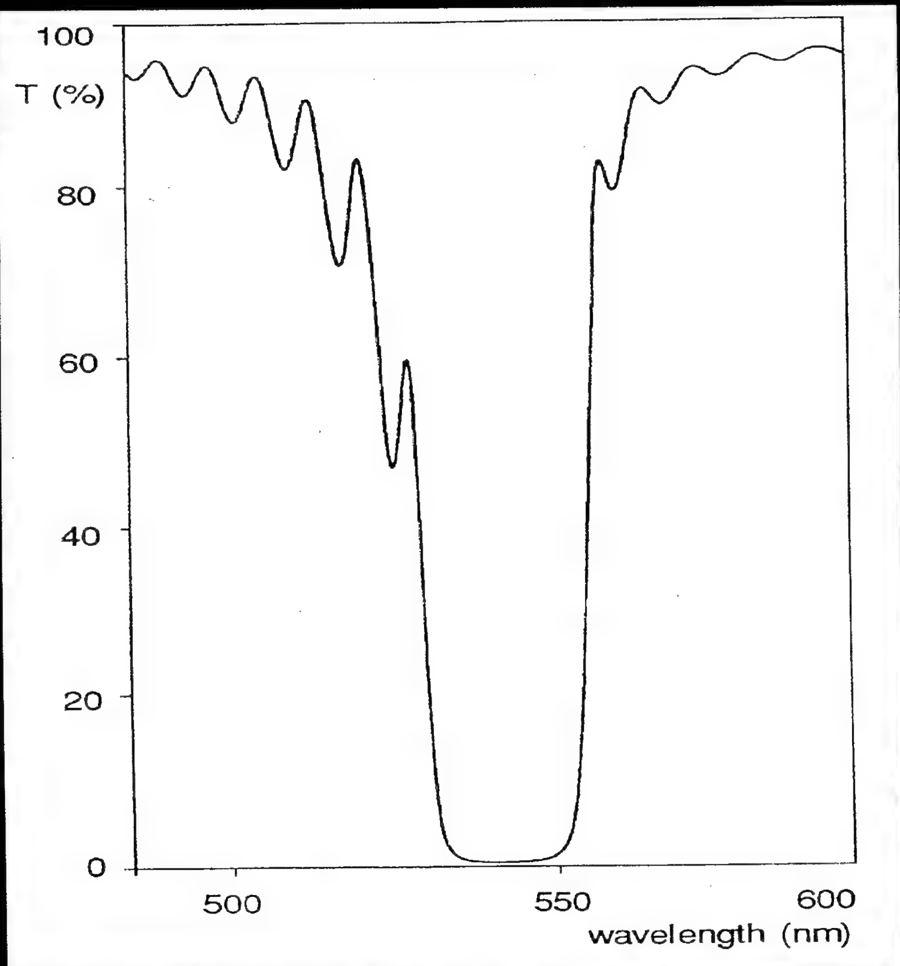
Working principle of the HNVG

Main elements are: 1 - the objective

2 - the I^2T

3 - the relay optics: collimator, roof mirror, relay lenses, mirror

4 - curved and flat HOE's

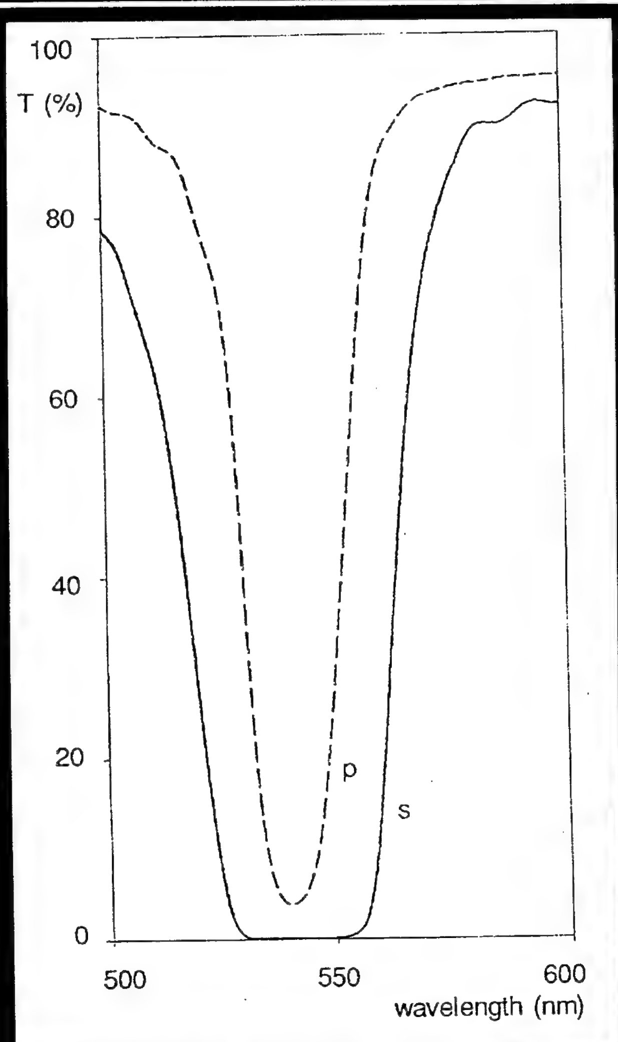


Transmision of the HOE's as a function of the wavelenth.

Curved HOE, angle of incidence 8°, unpolarized light

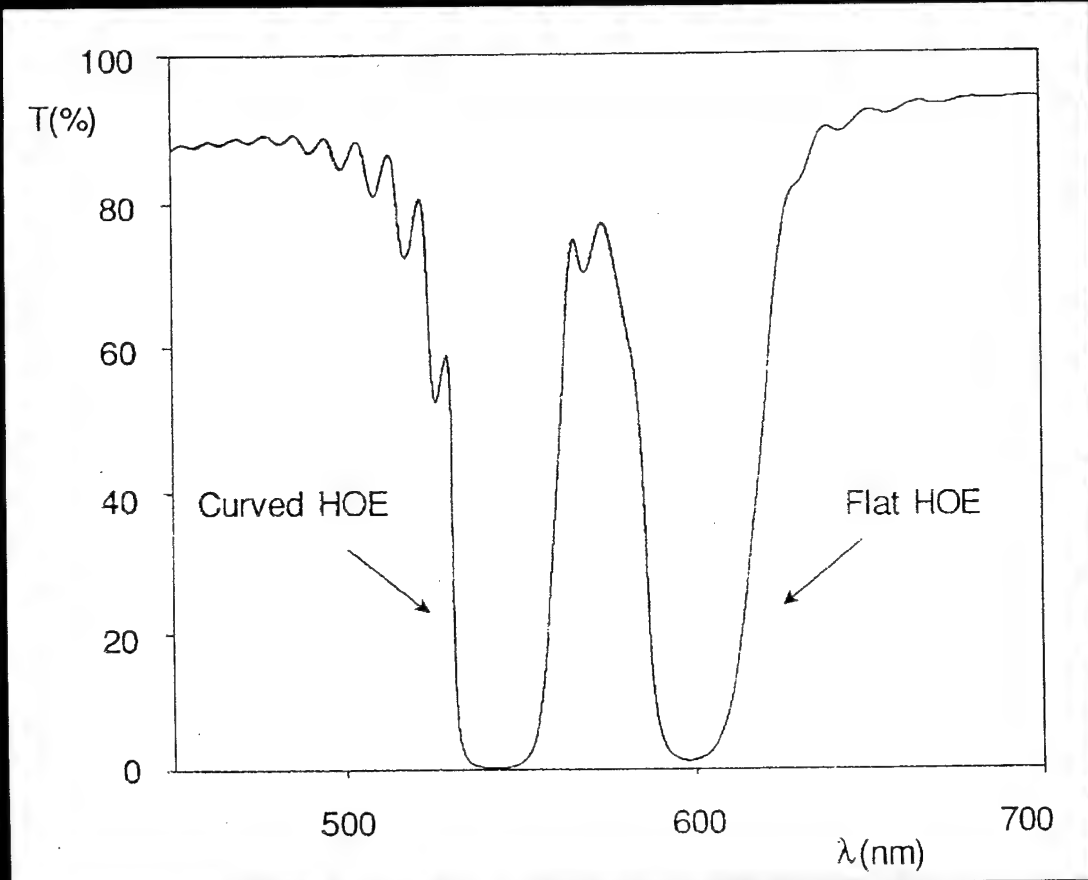
OIP N.V.

Delft Sensor Systems™



Transmision of the HOE's as a function of the wavelenth.

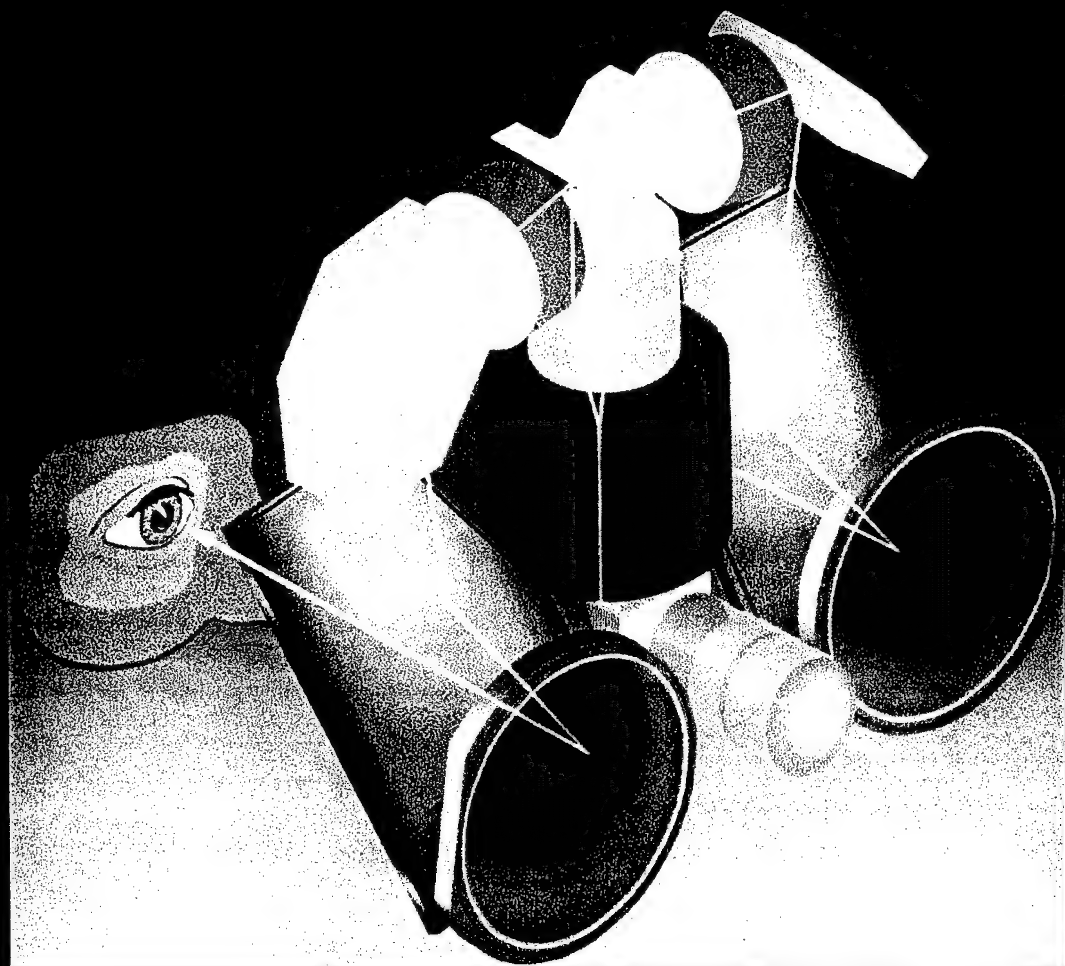
Flat HOE, angle of incidence 53°, s and p polarized light



Transmision of environmental light rays through the curved and flat HOE. The reconstruction wavelength of the flat HOE is shifted to higher wavelenghts, the environmental rays enter at the HOE at a smaller angle of incidence than the night image rays.

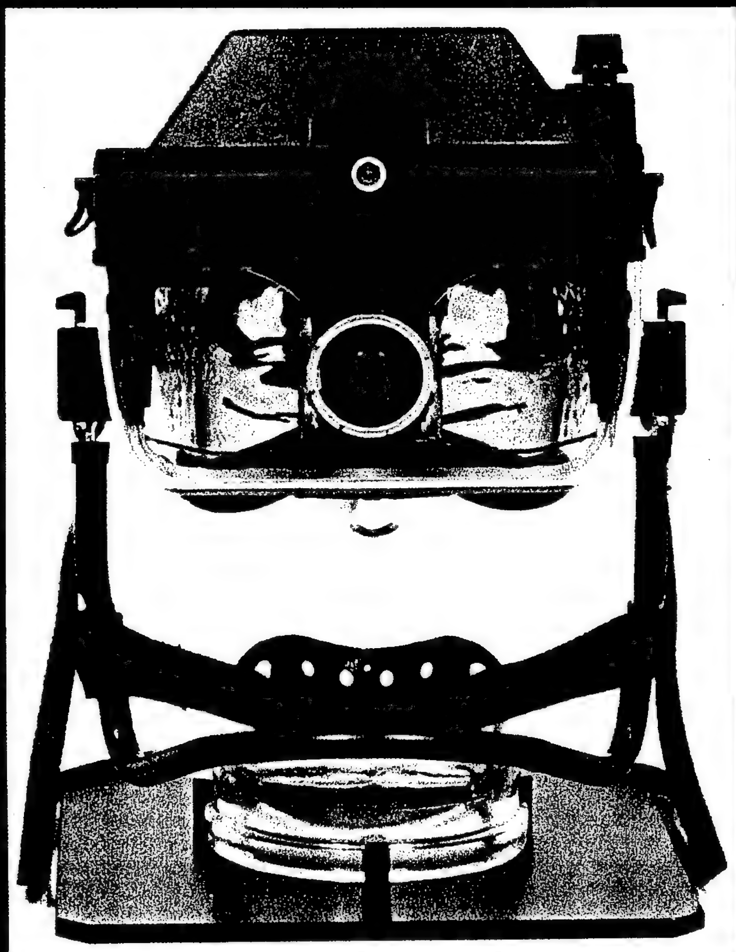
OIP N.V.

Delft Sensor Systems™



OIP N.V.

Delft Sensor Systems™



HNV-1 Goggles

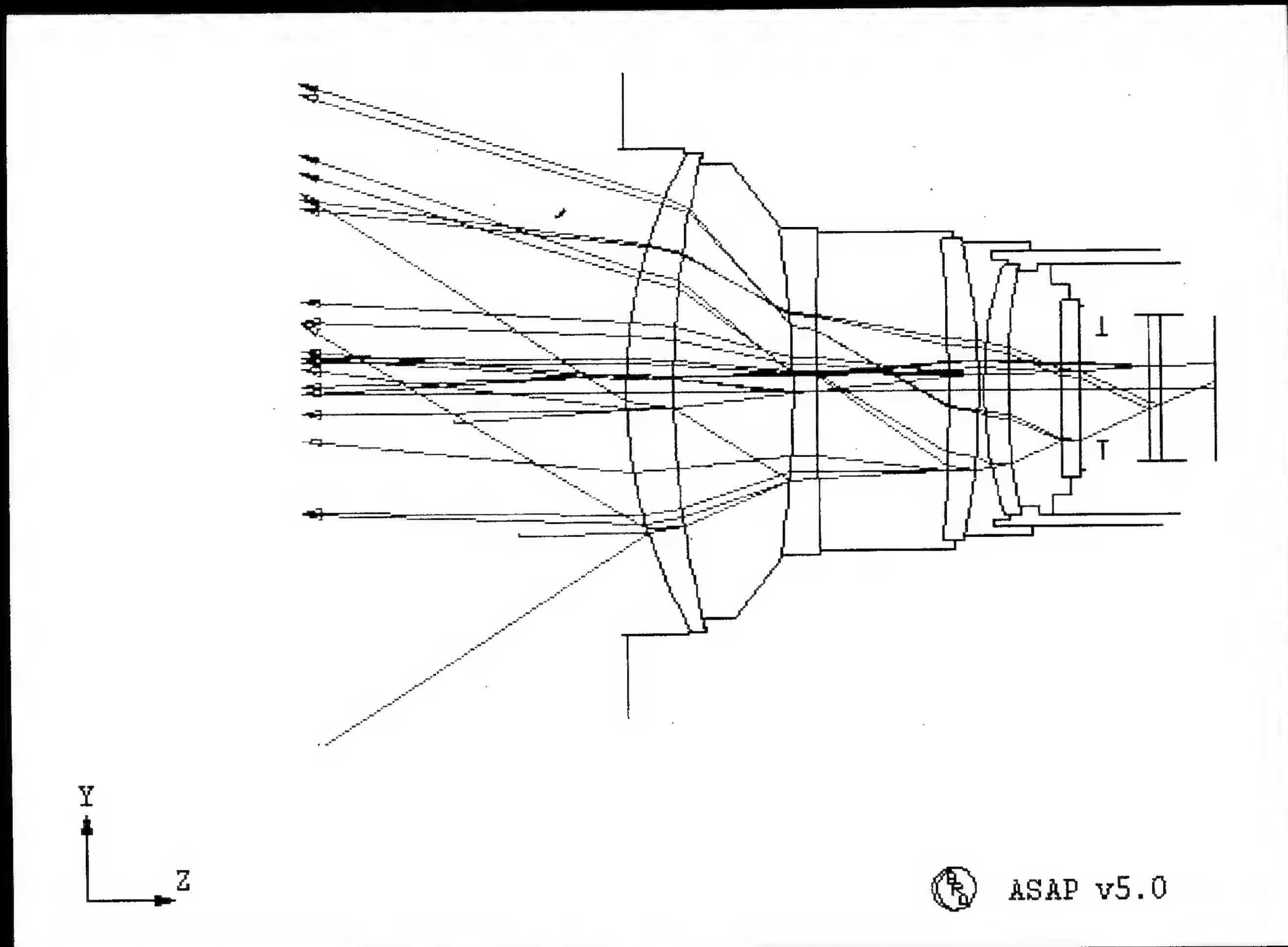
Standard Version

P/N 789.350

OIP N.V.

Delft Sensor Systems™

Stray Light Analysis of Objective



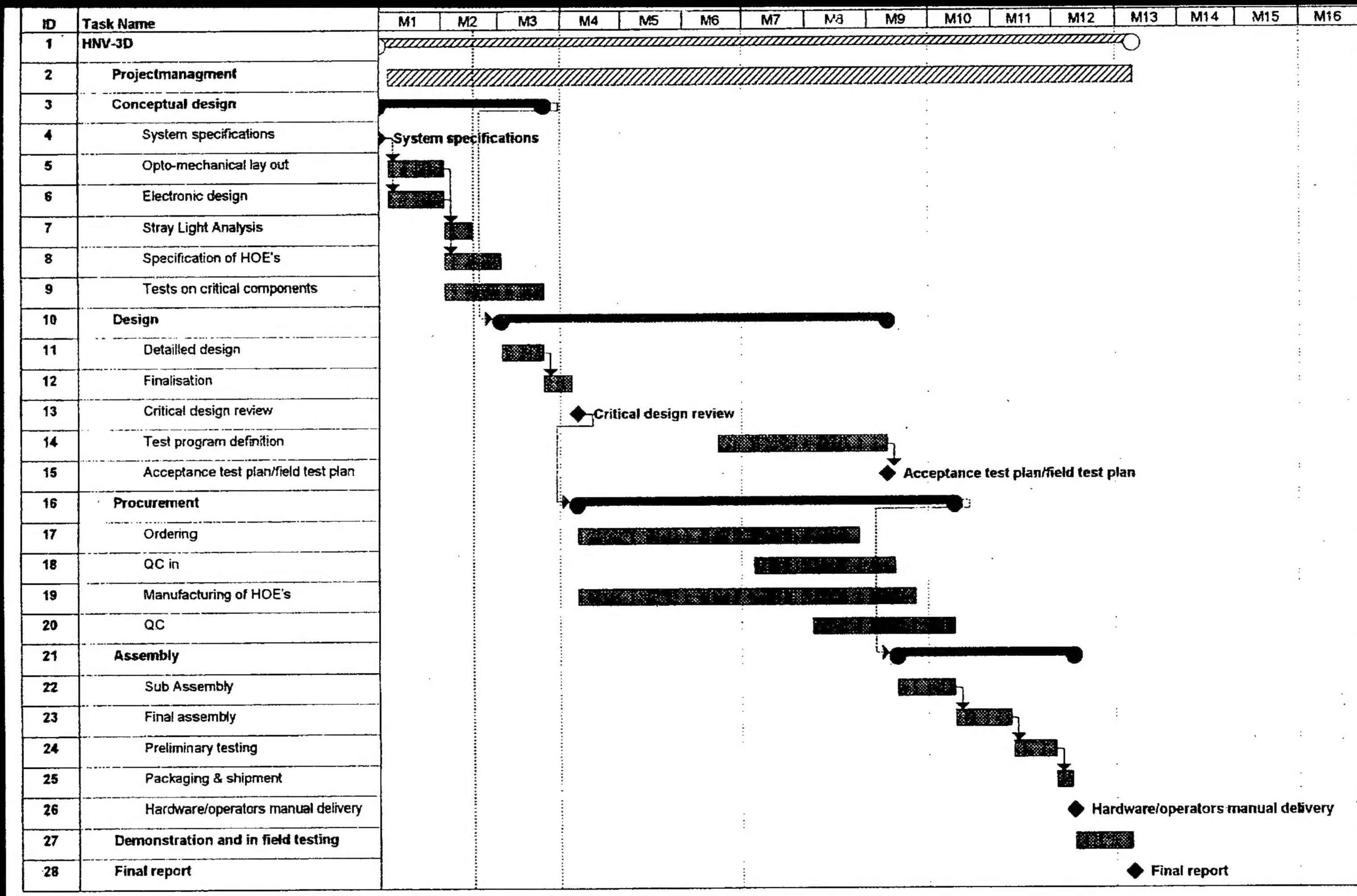
OIP N.V.

Delft Sensor Systems™

Flow chart of planned production schedule

OIP N.V.

Delft Sensor Systems™



OIP N.V.

Delft Sensor Systems™

Proposed test procedure

OIP N.V.

Delft Sensor Systems™

- Clinical evaluation of candidates three dimensional visual acuity
- Dimensioned tests at various light levels in the night training lab DSBL
- Comparative test of HNV-3D, PVS-7X, and monocular system
- Response time at rapid changes in light levels
- Familiar obstacle course
- Unfamiliar obstacle course
- Team operations with rapid changes in instructions